Capacitive deionization with graphene electrodes vs reverse osmosis for water desalination

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Fresh water scarcity is one of the major problems for more than a billion people around the world, mostly in arid developing countries. The World Health Organization predicts that by mid-century, four billion of us—nearly two-thirds of the world's present population—will face severe fresh water shortages, meaning that effective steps have to be taken, in terms of increasing water supply or managing water demand, to overcome this problem. Since 97.5% of water supplies are saltwater and only 0.3% of freshwater sources are readily drinkable, desalination is a key technology to increase both the quantity and quality of water supply. Commercial desalination technologies include reverse osmosis (RO) and thermal process (MSF). However, these processes consume large amounts of energy (2.9–3.7 kWh/m^3 of treated water for RO vs 4 kWh/m^3 for MSF) and have high maintenance costs. On the contrary, capacitive deionization (CDI), based on electrosorption, is membrane free and operates at low voltages which make it a promising low cost water desalination technique.

In the CDI process, ions from salty water are sequestered in an electrical double layer formed at the porous surface of the externally charged electrodes. This electrosorption process is mainly dependent on the physical properties and nanostructure of the electrode material, such as electrical conductivity, pore size distribution and pore structure. The ideal electrode material must have a high specific surface area for ionic accumulation, high electrical conductivity for effective charging, reasonable pore structure for electrical double-layer formation and ion accessibility, good electrolyte wettability and chemical and electrochemical stability [2]. Our group has developed a new material based on 3D graphene/metal oxide with high capacitance and good electrosorption capacity which could be ideal candidate as electrode for an efficient CDI process to compete favorably with RO in water desalination. In this work, the comparison of the efficiency and energy consumption of CDI and RO technologies is presented (Fig. 1).

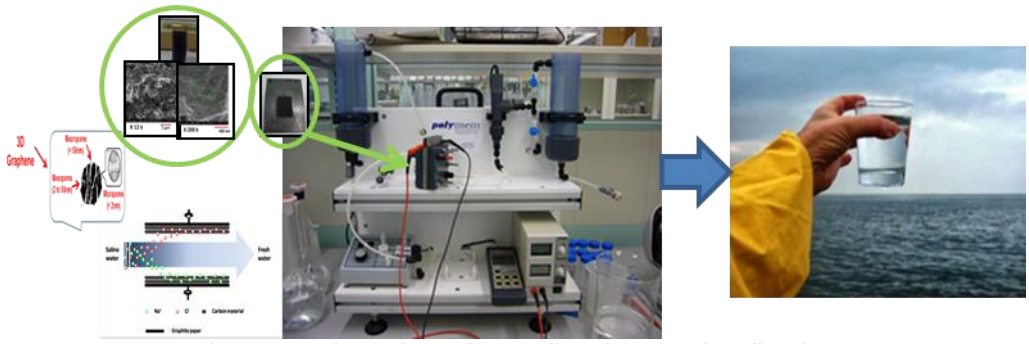

Fig. 1. Graphene based CDI pilot plant for desalination

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